APPENDIX H:

HYDROGEN SULFIDE

Hydrogen sulfide gas (H_2S) is a highly toxic gas that has a specific gravity of 1.192 at 60 F (air has a specific gravity of 1 at 60 F). It is a highly reactive gas and will corrode standard metals (the BLM requires the use of H_2S resistant alloys in the drilling and producing of hydrocarbons with associated H_2S). It burns with a blue flame and produces sulfur dioxide (SO_2), also a highly toxic gas. Hydrogen sulfide will disassociate itself from a natural gas stream in which it is mechanically mixed, and will tend to sink in the atmosphere due to its high specific gravity. The gas is, however, wind sensitive, and is readily carried and diluted by winds. The toxicity to humans of H_2S is outlined in Table H-1.

Table H-1: Effects of H_2S Gas on Humans

H_2S (ppm)[1]	0 to 2 minutes	1 to 4 hours
1 to 10	Can smell.	Mild throat irritation, can smell.
20 exposure.	Upper 8-hour safe limit. Can smell. Safe for 5 hours.	Eye stinging, throat irritation. May kill smell.
50	Mild eye, throat irritation; kills smell in 15+ minutes.	Coughing, eye irritation, smell killed.
100	Coughing, irritation of eyes, kills smell in 3 to 15 minutes. Burning of throat.	Coughing, sharp eye pain, throat pain.
200	Kills smell quickly; severe throat and eye irritation; coughing.	Difficulty breathing, sharp eye pain, blurred vision. Cannot smell.

[1] Values over 500 ppm will result in extreme weakness and death.

Source: Adapted from API Recommended Practice No. 59 and Various H_2S Safety Publications.

The risk of hydorgen sulfide blowout is a concern to the residents and users of the area However, the risk of a blowout occurring is minimal, as displayed in Table H-2.

Table H-2: Well Field Blowout Rates

Source	Blowouts Per Wells Drilled	Blowouts Per Producing Well
Texas1/ 1 per 270	1 per 20,000	
Alberta, Canada2/	1 per 630	1 per 3,000
Gulf of Mexico3/	1 per 250	Not given

Note: A blowout is defined as any uncontrolled release of gas to the atmosphere.

1/Texas data for years 1977-1981 from David W. Layton, Lawrence Livermore National Laboratory, Livermore, California, October 4, 1982. Blowouts per wells drilled includes dry holes.

2/Alberta, Canada, data for years 1970-1980 from David W. Layton, Lawrence Livermore Laboratory, California, October 4, 1982. Blowouts per wells drilled includes dry holes.

3/Production of Natural Gas from the Lower Mobile Bay Field, Alabama, Final Environmental Impact Statement, U.S. Army Corps of Engineers, 1982. For Gulf of Mexico data.

In the unlikely event a blowout were to occur, an analysis has been done for this "worst possible situation", such as at the mouth of Blackleaf Canyon (near the present producing wells), coupled with worse case meteorological conditions. The analysis indicates that H_2S concentrations passing by an individual at 2 miles downwind would be slightly less than 2 ppm. H_2S will tend to pool and to accumulate in low areas because of the high density of the gas. If a large uncontrolled blowout were to persist for 12 hours during the worst case meteorological conditions, H_2S concentrations could build to 15 ppm in the drainage bottoms of the EIS area at 2 mile distances downwind and to 50+ ppm at the wellsite.

In the event of such a major blowout, numerous federal regulatory agencies and company officials would be mobilized to evaluate the situation, and the well would be brought under control within several hours. Travel in the area would be restricted during this period. Thus, chances of a large uncontrolled blowout extending to 12 hours is extremely minimal.

If American Petroleum Institute (API) Guidelines are followed during drilling, the chances for a hydrogen sulfide breakout of any magnitude would be minimal. Precautions for drilling in H_2S environments as provided for in draft BLM Onshore Order No. 3, and API-recommended practices, are required for the safety of the drilling rig crew and the general public. These procedures include placement of H_2S monitors at critical locations around the drill rig, set to trigger a visual and an audible alarm if H_2S is detected above a certain level (about 10 ppm). Additional measures include placement of respirators for drillers' use, increasing the mud pH so that any H_2S bound in the mud would disassociate into sulfide and hydrogen ions, and addition of H_2S scavengers to the mud that would form stable compounds when they came in contact with H_2S.

In the event H_2S is encountered, the well could be shut-in with the blowout preventers (BOP), and any additional safety precautions taken to ensure proper control of the H_2S. In the extremely unlikely event of an uncontrolled blowout, the H_2S and natural gas would be flared forming a hot mixture of SO_2 that would readily volatilize and disperse, even in an inversion situation, due to its heat generated buoyancy.

Hydrogen sulfide emissions could also occur from possible pipeline ruptures; however, the risk of a pipeline rupture is extremely small.

An air quality model was used to evaluate the consequences of a gathering line rupture. Because the effects of a gathering line rupture are relatively local and the gathering systems are not in the immediate vicinities of population areas, the consequences analysis could be made in a generic manner, that is, not tied to a specific location for a gathering line rupture. A sensitivity analysis revealed that the predicted concentrations are highly sensitive to the assumptions made about the initial rise of the released gas. The results are also sensitive to variations in block valve spacing (if any), pipeline diameters, pressures, and assumed H_2S content. However, in general, the following conclusions can be drawn:

Low wind speed stable atmospheric conditions result in the worst-case H_2S concentrations. These conditions are estimated to occur less than 10 percent of the time.

A rupture of a 4-inch pipeline is not likely to result in lethal H_2S doses. However, an individual located within about 0.1 mile (600 feet) might experience eye irritation or a loss of smell (discomfort).

A rupture of a 6-inch pipeline could result in lethal doses to persons located within a few hundred feet. People within about 0.5 miles of the rupture could also experience discomfort.

A 12-inch pipe, if ruptured, could cause a lethal dose to a distance of about 0.25 to 1 mile depending on the prevailing weather conditions, specific pipeline design, and H_2S content of the gas.

The Blackleaf Field is anticipated to have 4 to 6-inch lines which, as shown above, would have no fatal impact in the unlikely event a rupture occurred. This, coupled with the area's low level of visitors, indicates that the addition of block valves is not necessary.